Appendix B: Optical pyrometer sample calibration report

In reply refer to: 844/123456-95

Radiometric Systems Inc.
Attn: John Doe
123 Calibration Court
Measurement City, MD 00000-0000

Subject: Optical Pyrometer Report of Calibration

Order No.: AB1234 dated January 1, 1995

Dear Mr. Doe:

Enclosed are results of the calibration you requested for Test Number 35040C Radiance Temperature Standard, Disappearing Filament Optical Pyrometer. Please refer to the above file number in any further communication concerning this calibration.

Sincerely,

Albert C. Parr, Chief
Optical Technology Division
Physics Laboratory

Enclosure:

One Report of Calibration

ACP/jah

NIST Cost Center 8443600

REPORT OF CALIBRATION

35040C Radiance Temperature Standard,
Disappearing Filament Optical Pyrometer

for

Model # Leeds and Northrup 8631-F, Serial # 0000000

Submitted by:

John Doe
Radiometric Systems Inc.
123 Calibration Court
Measurement City, MD 00000-0000

(See your Purchase Order No. AB1234 dated January 1, 1995)

1. Description of Calibration Item

An optical pyrometer was tested by the National Institute of Standards and Technology (NIST) as a standard of radiance temperature from 1149 °C (2100 °F) to 1482 °C (2700 °F).

2. Description of Calibration

The test pyrometer was measured in the NIST Radiance Temperature Calibration Facility using the equipment and procedures described in Ref. [1]. The NIST Photoelectric Pyrometer, which has a mean effective wavelength of 655.3 nm, was used to spectrally compare the variable-temperature blackbody to working standard SL20 to determine the radiance temperature of the blackbody at each calibration temperature. The portion of the test pyrometer lamp filament below the wire marker was matched in brightness to that of the blackbody and the test pyrometer scale reading was recorded at each calibration temperature. The NIST Photoelectric Pyrometer is described in the Ref. [1]

The variable-temperature blackbody has an estimated emissivity of 0.99. The blackbody cavity is a single piece of graphite, specially tapered for temperature uniformity. This graphite tube is cylindrically hollow on both ends to form two 2.54 cm diameter cavities with a common partition in the center. One cavity is used for temperature control and the other as a blackbody source.

Laboratory Environment:
Temperature: 23 °C ± 1 °C
Relative Humidity: 46% ± 5%

Calibration Date: January 2, 1995
NIST Test No.: 844/123456-95

The test pyrometer was operated according to the manufacturer's operating instructions. The pyrometer was calibrated from 1149 °C (2100 °F) to 1482 °C (2700 °F) on the high range (H). The pyrometer was aligned so that its optical axis, when viewing the variable-temperature blackbody, coincided with the geometrical center of the blackbody. The pyrometer was measured at a distance of 81.7 cm from the front surface of the objective lens holder to the blackbody cavity partition and was focussed on the center of the partition.

3. Results of Calibration

Table 1 gives the radiance temperature at 655.3 nm versus the test pyrometer scale reading.

Table 2 gives the calibration uncertainties relative to the International System of Units (SI Units). The expanded uncertainties $U = ku_c(T)$ (coverage factor $k = 2$) are two standard deviation estimates. Details on the estimation of these uncertainties are given in Ref. [1]. The NIST policy on uncertainty statements is described in Ref. [3].

4. General Information

The temperatures described in this report are radiance temperatures. The temperatures are stated with respect to the 1990 NIST Radiance Temperature Scale and correspond to temperatures when sighting on a Planckian radiator. See Ref. [2] for further details on the 1990 NIST Radiance Temperature Scale.

To maintain the highest accuracy, keep the optical components clean and have the pyrometer recalibrated periodically. Appropriate calibration schedules vary with instrument and application and are best determined by the user.

The results of this calibration apply only to the pyrometer referenced in this report. This report shall not be reproduced, except in full, without the written approval of the Radiance Temperature Measurements Calibration Service.

Prepared by:

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Approved by:

Robert D. Saunders
For the Director,
National Institute of
Standards and Technology
(301) 975-2355

Calibration Date: January 2, 1995
NIST Test No.: 844/123456-95

References

[1] C. E. Gibson, B. K. Tsai, and A. C. Parr, "Radiance Temperature Calibrations," *NIST Special Publication* **250-43** (1997).

[2] K. D. Mielenz, R. D. Saunders, A. C. Parr, and J. J. Hsia, "The 1990 NIST Scales of Thermal Radiometry," *J. Res. Natl. Inst. Stand. Technol.*, **95**, 621-629, (1990).

[3] B. N. Taylor and C. E. Kuyatt, "Guidelines for Evaluating and Expressing the Uncertainty of the NIST Measurement Results," *NIST Technical Note* **1297** (2nd ed., 1994).

TABLE 1
Radiance Temperature at 655.3 nm

Nominal Temperature [°C]	Blackbody Temperature (1990 NIST) [°C]	Blackbody Temperature [°F]	Pyrometer Scale Reading Value [°F]	Pyrometer Correction [°F]
High range (H)				
1148.9	1149.2	2100.6	2098	3
1315.6	1316.5	2401.7	2401	1
1482.2	1482.9	2701.2	2700	1

This equation was used to convert the blackbody temperature *T* from °C to °F:

$$T/°F = (1.8 \times T/°C) + 32$$

TABLE 2
Radiance Temperature Calibration Uncertainties

Source of Uncertainty	Type	Expanded Uncertainties (k = 2) [°C (°F)]		
		1148.9 °C (2100 °F)	1315.6 °C (2400 °F)	1482.2 °C (2700 °F)
1. Calibration of the variable temperature blackbody relative to the 1990 NIST Radiance Temperature Scale	B	0.3 (0.6)	0.4 (0.7)	0.4 (0.7)
2. Mean effective wavelength measurement for the NIST Photoelectric Pyrometer	B	0.0 (0.0)	0.0 (0.0)	0.1 (0.2)
3. Blackbody uniformity	B	0.2 (0.4)	0.2 (0.4)	0.2 (0.4)
4. Test pyrometer temperature determination	A	1.1 (2.0)	1.1 (2.0)	2.2 (4.0)
5. 1990 NIST Radiance Temperature Scale relative to the Thermodynamic Temperature Scale	B	0.3 (0.5)	0.3 (0.6)	0.4 (0.7)
Overall uncertainty of test lamp calibration with respect to SI units		**1.2 (2.2)**	**1.2 (2.2)**	**2.3 (4.1)**

Note: The expanded uncertainties in parentheses are in °F. The following equation was used to convert the blackbody temperature T from °C to °F: $T/°F = (1.8 \times T/°C) + 32$